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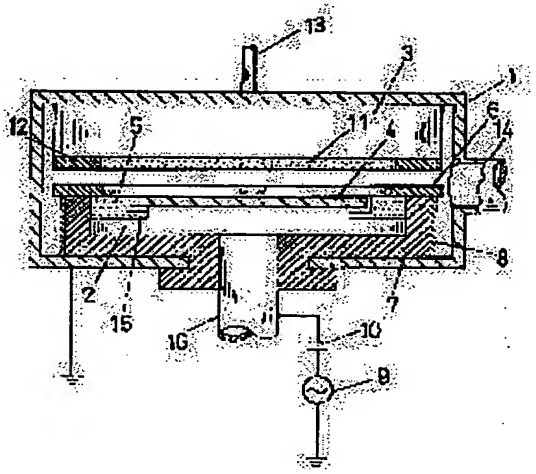
## (54) DRY ETCHING DEVICE

(57)Abstract:
PURPOSE: To provide a dry etching device, which allows a foreign substance to adhere to a wafer only a little even in its long-time use, is easily cleaned, is capable of generating even plasma all over the surface of the wafer and moreover, and is capable of making uniform a selection ratio to a material to be etched and the material of the base of material to be etched within the surface of the wafer.
CONSTITUTION: A sample placing electrode 2 and counter electrode 3 are installed in a vacuum treating chamber 1. The electrode 2 is provided with flat rings 5, which are installed on the outside of a substrate 4 to be treated and consist of a conductive material, and a flat ring 6, which consists of an insulating material, for covering the outer edge parts of the rings 5. Annular flanges 15, which overlap with the edge parts on the side of the rear of the substrate 4, are respectively formed on the insides of the rings 5.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the dry etching system used mainly at the etching process of the semiconductor wafer in manufacture of a semiconductor device.
[0002]
[Description of the Prior Art] Conventionally, generally at the etching process for semiconductor device manufacture, the dry etching system which used the parallel plate electrode was used. Especially, the single-wafer-processing dry etching system which processes one processed one-sheet substrate is becoming general with diameter[ of macrostomia ]-izing of a wafer (it is also called a processed substrate).
[0003] In order to raise productivity, as compared with the so-called batch type equipment of the conventional format which carries out several multi-sheet batch processing, single figure processing speed needed to be raised with the equipment of the format of this single wafer processing.
[0004] for this reason — for example, with the single-wafer-processing dry etching system of an oxide film, the so-called narrow gap type etching system which sets spacing of an parallel plate electrode to 10mm or less, and etches by the high high-frequency power consistency was well used by the pressure of 1Torr extent. In the equipment of this narrow gap type, in order to raise the plasma consistency generated by inter-electrode, the flat wafer ring which becomes by the insulating material was installed in the perimeter of the wafer which is a processed substrate, the electrode spacing of the part of the wafer ring of a periphery was narrowed as compared with the electrode spacing of the part in which a wafer exists, and the means it was made to shut up the plasma inside a wafer ring was known.
[0005]
[Problem(s) to be Solved by the Invention] When the means which shuts up the plasma using the above wafer rings is adopted in a narrow gap type etching system, In the part of the wafer ring of the part in which the plasma was confined which narrowed the outside part, i.e., an electrode spacing, immediately It was, also when it was used [ long duration ], without carrying out cleaning of a deposit, and it not only becomes complicated removing [ of the affix generated and deposited ] a lot of affixes, but an affix exfoliated and a lot of foreign matters adhered to a wafer front face into dry etching. When the clamp to a wafer, the wafer ring which becomes by the insulating material installed since the plasma was shut up were in the electrode which supports especially a wafer, a lot of affixes had accumulated on the paries-medialis-orbitae (plasma and field which counters) edge section of these members.
[0006] Moreover, the electrode (generally alumite processing of the front face is carried out by the product made from aluminum.) with which it was not avoided that a minute clearance is formed between said wafer rings and wafers, but it supported the wafer in the part of this clearance had to come to be directly put to the plasma. Thus, when there was a part by which an electrode is directly put to the plasma, in this part, the plasma state might become uneven, and, for this reason, the etch rate to the periphery section of a wafer might become an unusual value as compared with the etch rate in the center section of the wafer.

[0007] Furthermore, it was also difficult to secure the homogeneity within the wafer side of the etch rate to the etched ingredient in a wafer front face, and the ingredient which constitutes the substrate of the ingredient. For this reason, the selection ratio in etching processing will change in a wafer side, and had also produced the trouble that the configuration of a contact hole will vary in an ununiformity in a wafer side, in the formation process of a detailed contact hole.
[0008] It was made in view of the above troubles, and this invention has little adhesion of the foreign matter to a wafer top also to use of long duration, moreover is easy to clean, and it continues all over a wafer, and the uniform plasma can be generated, and it aims at offering the dry etching system which can equalize the selection ratio to an etched ingredient and the ingredient of that substrate in a wafer side further.
[0009]
[Means for Solving the Problem] The dry etching system of this invention that attains said purpose In the equipment which carries out dry etching of the front face of a processed substrate by the reactant gas plasma which prepared the parallel electrode of two sheets in the vacuum processing interior of a room mutually, supported the processed substrate to one electrode, and was made to generate by inter-electrode [ of two sheets ] The flat ring which while supports said processed substrate and becomes an electrode with the conductive ingredient arranged on the outside of a processed substrate, The inside edge of the flat ring which is equipped with the flat ring which becomes with the insulating ingredient of a wrap sake about the rim section of this flat ring, and becomes with said conductive ingredient is characterized by having put on the rear-face side edge section of a processed substrate.
[0010] Thus, as for opposite spacing of an electrode, in the constituted dry etching system, it is desirable to maintain to 4mm or more 20mm or less. It is for it becoming difficult to confine the plasma's in inter-electrode, if it is difficult to make the plasma generate in less than 4mm and it exceeds 20mm, and coming to spread in the whole vacuum processing interior of a room.
[0011] As for the flat ring of a conductive ingredient, it is desirable flat-tapped with the front face of a processed substrate thru/or to form in the thickness it is thin in height of 2mm or less. If the front face of a flat ring is retreating from the front face of a processed substrate, in case a processed substrate will be conveyed, when it is because a processed substrate may move and recovery impossible and breakage may be produced and has projected exceeding 2mm, it is because the homogeneity of the plasma is spoiled and uniform etching becomes difficult.
[0012] Moreover, as for the width of face of the part which the flat ring of this conductive ingredient exposes to the reactant gas plasma, it is desirable to be referred to as 10mm or more 30mm or less. When the boundary in which the plasma is confined in less than 10mm approaches a wafer too much, it is because it is not desirable on generating of a foreign matter and 30mm is exceeded, it is because the power density to a processed base gets down and the part and big power are needed.
[0013] Furthermore, it is desirable to maintain a clearance 0.2mm or more 1mm or less between the inside edge of the flat ring of a conductive ingredient and the rear-face side edge section of a processed substrate. It is because the polymer adhering to said inside edge becomes the height to which it is several etching and a processed base is floated in a less than 0.2mm clearance, and is because the reactant gas plasma is turned and crowded in the clearance exceeding 1mm.
[0014] As for the flat ring of a conductive ingredient, it is desirable to constitute from an ingredient homogeneous as the quality of the material which forms the substrate of the film set as the object of etching in a processed substrate. It is for reducing the etch rate to a substrate and securing a high selection ratio using a loading effect.
[0015] For example, a processed substrate is a silicon wafer, and when etching a surface oxide film, it is desirable [ the flat ring of a conductive ingredient ] to constitute from the ingredient or carbon containing silicon, such as single crystal silicon, polish recon, and carbonization silicon.
[0016]
[Function] According to the dry etching system of this invention, the field where the consistency of the reactant gas plasma generated in inter-electrode is uniform can be extended to the part of the flat ring which becomes with a conductive ingredient across the edge of a processed

substrate. For this reason, the field which an affix generates can be kept away from the edge of a processed substrate, and foreign matter adhesion can be reduced. Moreover, since attachment and detachment of the flat ring which becomes with a conductive ingredient are easy, the troublesomeness of cleaning can also improve it sharply.
[0017] Moreover, since the inside edge of the flat ring which becomes with a conductive ingredient was put on the rear-face side edge section of a processed substrate, the electrode itself which supported the processed substrate can lose the part put to the direct plasma. For this reason, the ununiformity of the plasma state cannot be caused and the unusual etch rate in the edge of a processed substrate can be avoided.
[0018] Furthermore, since the rim section of the flat ring which becomes with a conductive ingredient was covered in the flat ring which becomes with an insulating ingredient, in this boundary part, the uniform reactant gas plasma does not have a possibility that abnormality discharge may arise, either, and it it not only can shut it up inside the flat ring which becomes with an insulating ingredient, but is made.
[0019] Moreover, by choosing the quality of the material of the flat ring which becomes with a conductive ingredient, it is possible to equalize the selection ratio in a processed substrate edge with the selection ratio in the center of a substrate, and the field internal division cloth of a selection ratio can be improved.
[0020]
[Example] Hereafter, the example of the dry etching system to the oxide film of a silicon wafer is explained with reference to drawing.
[0021] The sample installation electrode 2 made from aluminum with which the dry etching system shown in drawing 1 performed alumite processing to the interior of the vacuum processing room 1 made from aluminum on the front face, and the sample installation electrode 2 and the counterelectrode 3 of this quality of the material which were made to counter in parallel with this are installed. The sample installation electrode 2 and a counterelectrode 3 are all disc-like. The wafer 4 silicon oxide was formed in the front face of a processed substrate, i.e., a silicon wafer, at the sample installation electrode 2, and patterning was carried out [ the wafer ] by the photoresist is laid, and the flat ring 5 made from single crystal silicon is put on the perimeter of a wafer 4. annular to the edge of the wafer 4 of the flat ring 5, and the inside which counters -- a collar 15 -- forming -- **** -- this -- annular -- it is constituted so that a collar 15 may lap with the rear-face side edge section of a wafer 4, and the flat ring 5 is annular -- between the rear faces of a collar 15 and a wafer 4, it is constituted so that a clearance 0.5mm or less may be made. Furthermore, the flat ring 5 is constituted so that it may touch by width of face of 15mm to the plasma of the reactant gas formed between the sample installation electrode 2 and a counterelectrode 3, and it may be constituted and the front face of the flat ring 5 and a wafer 4 may become flat-tapped. The flat ring 6 which consisted of polyarylate resin which is an insulating ingredient is installed in the outside of the flat ring 5, and the rim section of said flat ring 5 is completely covered with the flat ring 6. Furthermore, the side face of the sample installation electrode 2 is covered with shielding 8 through the insulator 7, and RF generator 9 is connected to the introductory tubing 16 which penetrated the bottom wall of the vacuum processing room 1 through the capacitor 10. The gas blow-off plate 11 of a carbon system is attached in the field which touches the plasma of a counterelectrode 3, and the counterelectrode covering 12 which consisted of polyarylate resin is attached in the perimeter, and it is constituted so that it may counter with said flat ring 6. Spacing which consisted of this examples with 7mm, and the flat ring 6 and the counterelectrode covering 12 in the electrode spacing which consisted of a wafer 4 and a gas blow-off plate 11 was set to 3mm.
[0022] for operating the dry etching system of the above-mentioned example -- exhaust air -- the vacuum processing room 1 is beforehand exhausted to the degree of vacuum of about 10 - 3Pa with the exhauster (not shown) connected through the conduit 14, and, subsequently a wafer 4 is conveyed on the sample installation electrode 2 according to the wafer conveyance device which is not illustrated. next, the gas installation tubing 13 to CHF3 helium and O2 mixed gas -- the inside of the vacuum processing room 1 -- introducing -- exhaust air -- a conduit 14 -- on the way -- the pressure of the vacuum processing room 1 is kept at about 70Pa which is

an etching pressure, adjusting the conductance of the throttle valve (not shown) boiled and attached. RF generator 9 is turned on in the appropriate back, and high-frequency power is impressed to the sample installation electrode 2. At this time, the reactant gas plasma is shut up by homogeneity in the field which consists of flat rings 5 which become with the inside wafer 4 and the inside conductive ingredient of the flat ring 6 which is an insulating ingredient. The uniform field of this plasma reaches even the field exposed to the plasma of the flat ring 5 outside a wafer 4 since the flat ring 5 is conductivity, and etching processing is performed under the plasma with a uniform wafer 4. For this reason, the abnormalities of the etch rate in the edge of a wafer 4 produced conventionally are no longer observed hardly. Furthermore, since the field which a deposit produces when etching is repeated and is performed since the border area of discharge becomes 15mm outside from the edge of a wafer 4 became the medial surface of the flat ring 6 and it is separated from the wafer 4, even when prolonged etching is performed, adhesion of the foreign matter to a wafer top can be lessened as much as possible. Furthermore, a lot of deposits arise in the boundary section of the plasma of the 11th page of a gas blow-off plate, and this part and the number of the foreign matters which a deposit separates and adhere to a wafer 4 since it is separated from right above [ of the front face of a wafer 4 ] fall extremely. the flat ring 5 is annular -- since the collar 15 is covered with the edge of a wafer 4, discharge does not cause the abnormality discharge in entering in the minute clearance between the edges of the flat ring 5 and a wafer 4 furthermore, the edge rear face of a wafer 4 and the flat ring 5 are annular -- since the minute clearance (this example about 0.5mm) is prepared between collars 15, when the rear face of a wafer 4 is dirty or several many wafers 4 are etched, the flat ring 5 is annular -- it can prevent a wafer 4 losing touch with the sample installation electrode 2 for the polymer adhering to a collar 15. Furthermore, the quality of the material of the flat ring 5 is silicon, since it is an ingredient homogeneous as the silicon which forms the substrate of the silicon oxide which is an etched ingredient, since there is much radical amount of supply, the etch rate of the silicon of a edge does not become quick and the selection ratio in a wafer center section and the selection ratio in a wafer edge do not necessarily serve as an ununiformity at the edge of a phenomenon peculiar to radical character etching, i.e., a wafer. This is because F radical is consumed with the conductive flat ring 5 like a wafer center section also at the edge of a wafer. For this reason, very good etching of the homogeneity in a wafer of etch selectivity is attained. Moreover, since it had only put on the sample installation electrode 2, while attachment and detachment are very easy and lost the troublesomeness at the time of cleaning, the large compaction of cleaning time amount of the flat ring 5 and the flat ring 6 was attained.

[0023] In this example, since the plasma will not be shut up between two electrodes but will spread in [ whole ] the vacuum processing room 1 if an electrode spacing exceeds 20mm although the electrode spacing was set as 7mm, and it is not necessary to limit especially this value to this, etching at high speed will become impossible. moreover -- even if the quality of the material of the flat ring 5 which becomes with a conductive ingredient is not limited to single crystal silicon, and is polish recon and it is silicon carbide -- carbon -- you may be -- in short -- conductivity -- it is -- in addition -- and F which is etchant which etches the silicon of the substrate of the etching film -- the matter which can be etched [ that it is radical and ] -- it is -- ****ing -- things cannot be overemphasized. Though natural, when the quality of the materials of the substrate of the etching film are other quality of the materials, the quality of the material of the flat ring 5 is also changed according to the quality of the material of a substrate. Moreover, although not limited to this example, the width of face of the part put to the plasma of this flat ring 5 is not desirable from generating of a foreign matter, in order that the boundary in which the plasma is confined may approach the edge of a wafer 4 too much, while the effectiveness of consuming the etchant to the silicon of a substrate becomes less enough, when that width of face is set to 10mm or less. moreover, the rear face of a wafer 4 and the flat ring 5 are annular -- if spacing is not much large, since the plasma will be turned and crowded into this part, as for the clearance between collars 15, it is desirable to set it as 1mm or less. Moreover, the quality of the material of the flat ring 6 which becomes with an insulating ingredient, and the counterelectrode covering 12, the quality of the material of the gas blow-off plate 11, etc. are

not limited to this example. Furthermore, the flat ring 5 can also consist of two flat rings 5a and 5b, as shown in drawing 2 .

[0024]

[Effect of the Invention] the phenomenon in which according to this invention there is little mixing of the foreign matter to a processed substrate, and the processed substrate internal division cloth of a selection ratio is good, and the etch rate in the edge of a processed substrate differs from other parts remarkably further -- not happening -- in addition -- and it is effective in the ability to offer the very easy etching system of cleaning.

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]
[Drawing 1] It is the outline sectional view of the important section of the reactive ion etching system of the example of this invention.
[Drawing 2] It is the sectional view of the part of the flat ring which becomes with the conductive ingredient in other examples of this invention.
[Description of Notations]
1 Vacuum Processing Room
2 Sample Installation Electrode
3 Counterelectrode
4 Wafer
5, 5a, 5b Flat ring which becomes with a conductive ingredient
6 Flat Ring Which Becomes with Insulating Ingredient
7 Insulator
8 Shielding
9 RF Generator
10 Capacitor
11 Gas Blow-Off Plate
12 Counterelectrode Covering
15 Annular -- Collar

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is the sectional view of the etching system of common use.
[Drawing 2] Drawing 2 is the sectional view of a desirable etching system.

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DRAWINGS

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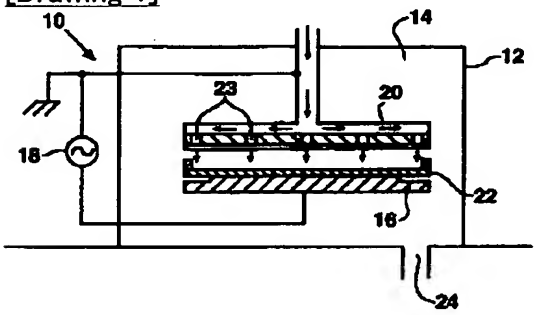
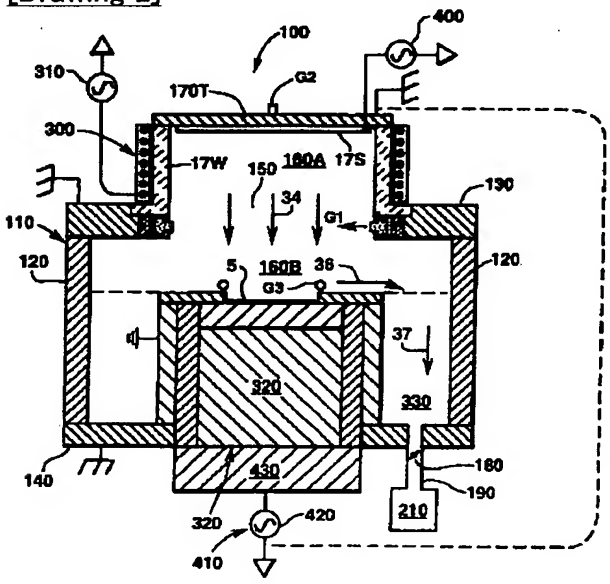
[Drawing 1]




[Drawing 2]

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